EEE2006 Lab Experiment 3

Name: Harit Goel
Reg. Number: 18BEE0379
Slot: L45+L46

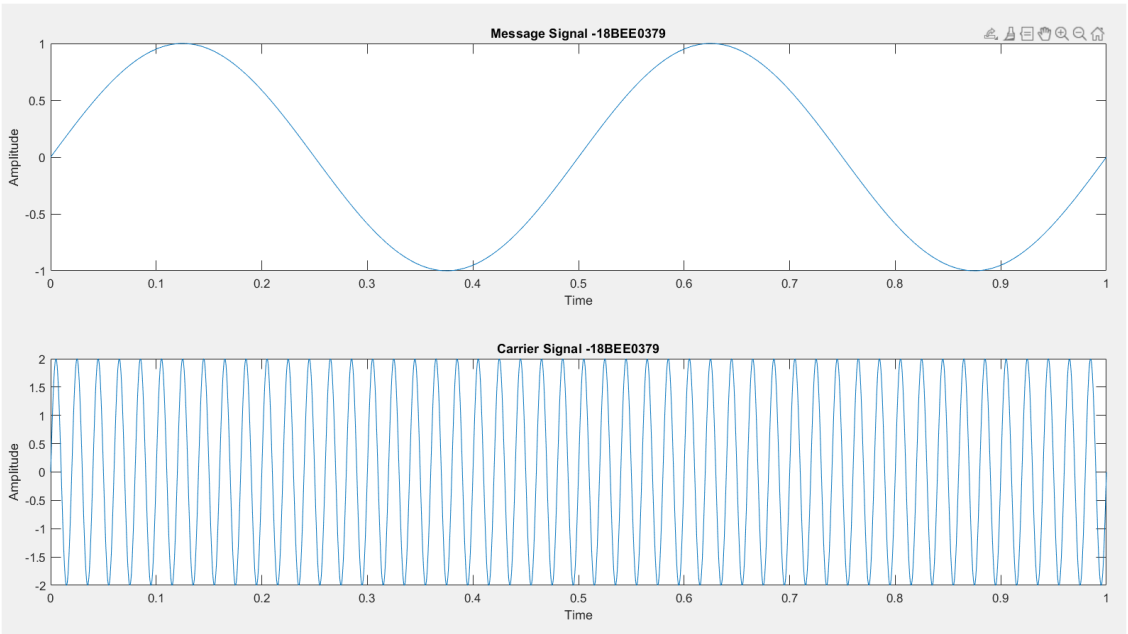
1. Generate and demodulate FM modulation with and without presence of noise using matlab

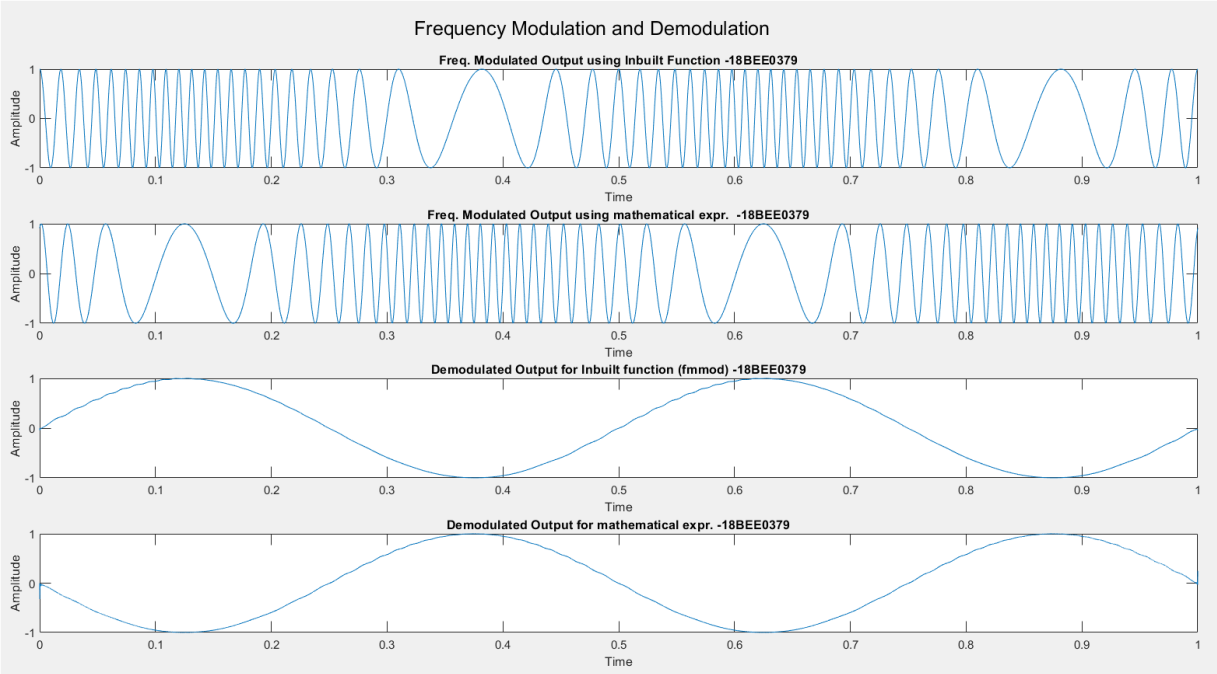
MATLAB CODE:

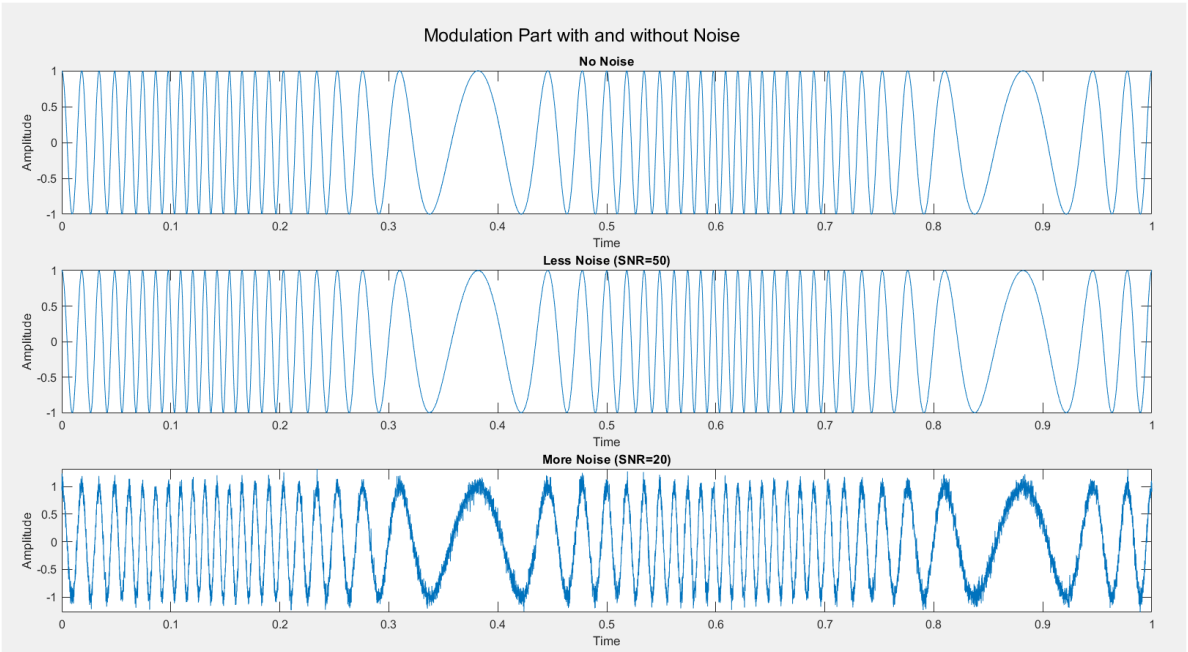
```
clc
clear
close all;
vm = 1;
fs = 10000;                         % Sampling Frequency
fc = 50;                            % Carrier Frequency
fm = 2;                             % Message Frequency
t = 0:1/fs:2/fm;
v = vm*sin(2*pi*fm*t);              % Message Signal
subplot(2,1,1);
plot(t,v);
xlabel("Time");ylabel("Amplitude");
title("Message Signal -18BEE0379");

fdev=40;                                    % Frequency Deviation
vc = 2; v1 = vc*sin(2*pi*fc*t);             % Carrier Signal
subplot(2,1,2);
plot(t,v1);
xlabel("Time");ylabel("Amplitude");
title("Carrier Signal -18BEE0379");

%% Frequency Modulation
vinfm = fmmod(v,fc,fs,fdev);
figure(2);
subplot(4,1,1)
plot(t,vinfm);
xlabel("Time"); ylabel("Amplitude");
title('Freq. Modulated Output using Inbuilt Function -18BEE0379');

m=20; % Modulation Index
v2=sin(2*pi*fc*t+(m*cos(2*pi*fm*t)));
subplot(4,1,2); plot(t,v2);
xlabel("Time"); ylabel("Amplitude");
title('Freq. Modulated Output using mathematical expr.  -18BEE0379');

%% Frequency Demodulation
vinfm_demod = fmdemod(vinfm,fc,fs,fdev);
v2_demod  = fmdemod(v2,fc,fs,fdev);

subplot(4,1,3); plot(t,vinfm_demod);
xlabel("Time"); ylabel("Amplitude");
title('Demodulated Output for Inbuilt function (fmmod) -18BEE0379');
subplot(4,1,4); plot(t,v2_demod);
xlabel("Time"); ylabel("Amplitude");
title('Demodulated Output for mathematical expr. -18BEE0379');
sgtitle('Frequency Modulation and Demodulation');
```

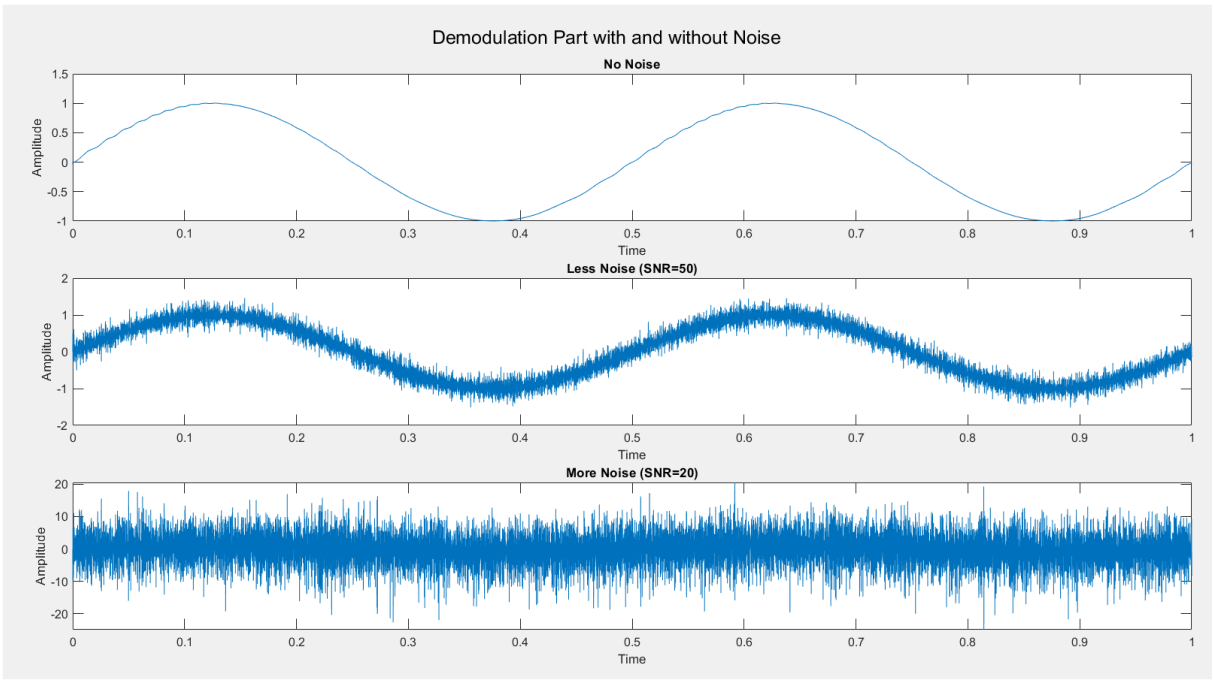
```
%% AWGN
%No Noise
v_no = vinfm;
v_no_d = fmdemod(vinfm,fc,fs,fdev);

% Less Noise
SNR = 50;
v_less = awgn(vinfm,SNR);
v_less_d = fmdemod(v_less,fc,fs,fdev);

%More Noise
SNR = 20;
v_more = awgn(vinfm,SNR);
v_more_d = fmdemod(v_more,fc,fs,fdev);

%Modulation Part
figure(3);
subplot(3,1,1); plot(t,v_no);
xlabel("Time"); ylabel("Amplitude"); title('No Noise');
subplot(3,1,2); plot(t,v_less);
xlabel("Time"); ylabel("Amplitude"); title('Less Noise (SNR=50)');
subplot(3,1,3); plot(t,v_more);
xlabel("Time"); ylabel("Amplitude"); title('More Noise (SNR=20)');
sgtitle("Modulation Part with and without Noise");

%Demodulation Part
figure(4);
subplot(3,1,1); plot(t,v_no_d);
xlabel("Time"); ylabel("Amplitude"); title('No Noise');
subplot(3,1,2); plot(t,v_less_d);
xlabel("Time"); ylabel("Amplitude"); title('Less Noise (SNR=50)');
subplot(3,1,3); plot(t,v_more_d);
xlabel("Time"); ylabel("Amplitude"); title('More Noise (SNR=20)');
sgtitle("Demodulation Part with and without Noise");
```

OUTPUT:




Frequency Modulation and Demodulation
Freq. Modulated Output using Inbuilt Function -18BEE0379
Freq. Modulated Output using mathematical expr. -18BEE0379
Demodulated Output for Inbuilt function (fmmod) -18BEE0379
Demodulated Output for mathematical expr. -18BEE0379
Amplitude
Time


Modulation Part with and without Noise
No Noise
Less Noise (SNR=50)
More Noise (SNR=20)
Amplitude
Time


Demodulation Part with and without Noise
No Noise
Less Noise (SNR=50)
More Noise (SNR=20)
Amplitude
Time

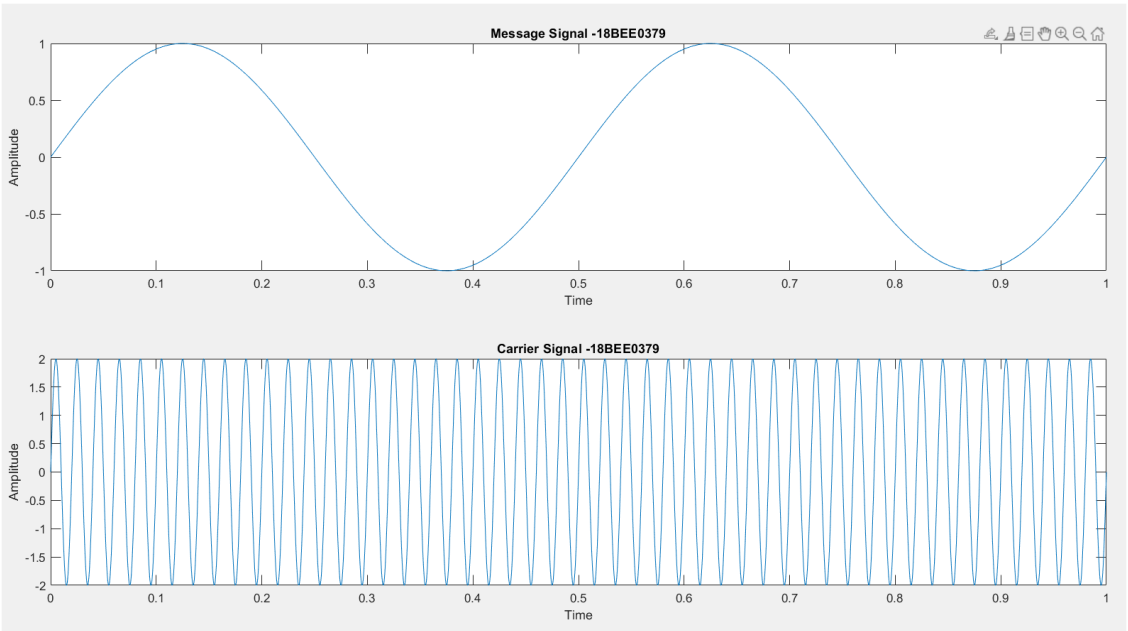
2. Generate and demodulate PM with and without the presence of noise using matlab

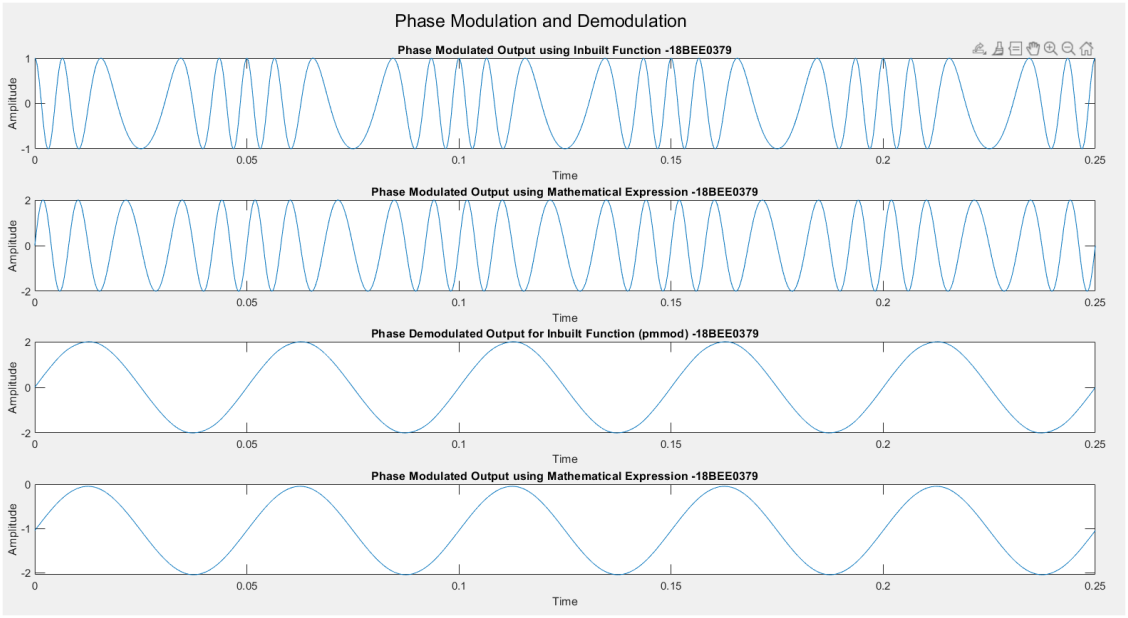
MATLAB CODE:

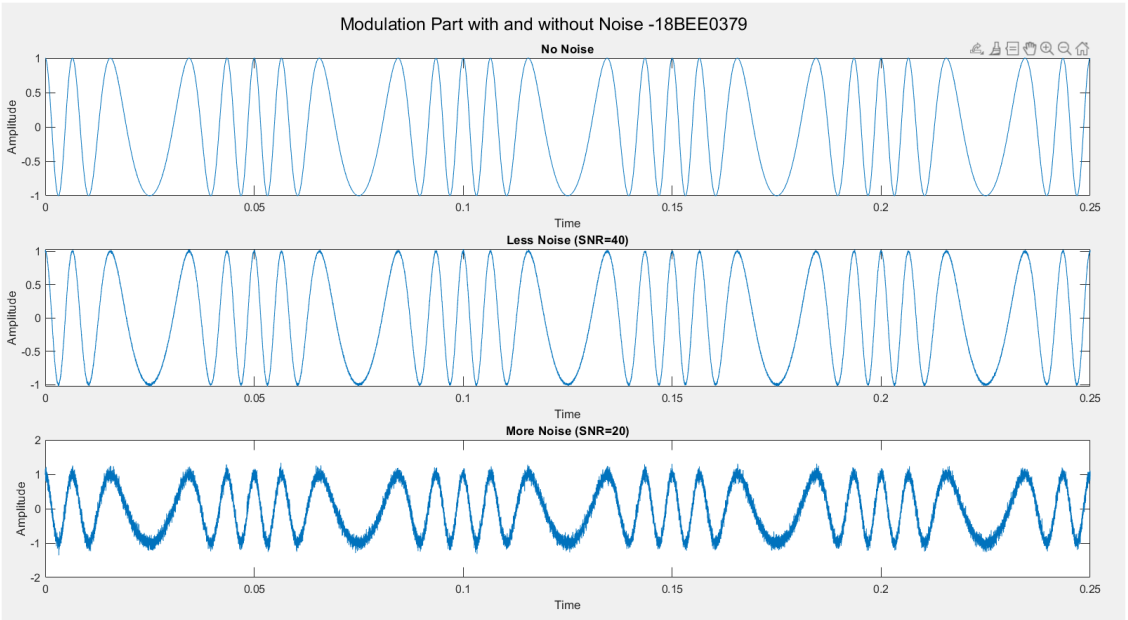
```
clc
clear
close all;

vm=2;
vc=2;
fm=20;                                  %Message Frequency
fc=100;                                 %Carrier Frequency
fs=100000;                              %Sampling Frequency
t=0:1/fs:5/fm;
figure(1);
v=vm*sin(2*pi*fm*t);                    %Message signal
subplot(2,1,1);plot(t,v);
xlabel("Time");ylabel("Amplitude");
title("Message Signal -18BEE0379");

pd=1.5;                                 %Phase Deviation
v1=vc.*sin(2*pi*fc*t);                  %Carrier Signal
subplot(2,1,2);
plot(t,v1);
xlabel("Time");ylabel("Amplitude");
title("Carrier Signal -18BEE0379");


%% Phase Modulation

figure(2);
mp=1.5;
vinpm = pmmod(v,fc,fs,pd);
subplot(4,1,1); plot(t,vinpm);
xlabel("Time"); ylabel("Amplitude");
title('Phase Modulated Output using Inbuilt Function -18BEE0379');

v2=vc*sin(2*pi*fc*t+mp*sin(2*pi*fm*t));
subplot(4,1,2);plot(t,v2);
xlabel("Time"); ylabel("Amplitude");
title('Phase Modulated Output using Mathematical Expression -18BEE0379');

%% Phase Demodulation

vinpm_demod=pmdemod(vinpm,fc,fs,pd);
v2_demod=pmdemod(v2,fc,fs,pd);

subplot(4,1,3);plot(t,vinpm_demod);
xlabel("Time"); ylabel("Amplitude");
title('Phase Demodulated Output for Inbuilt Function (pmmod) -18BEE0379');

subplot(4,1,4);plot(t,v2_demod);
xlabel("Time"); ylabel("Amplitude");
title('Phase Modulated Output using Mathematical Expression -18BEE0379');
sgtitle('Phase Modulation and Demodulation');

%% AWGN

%No Noise
```

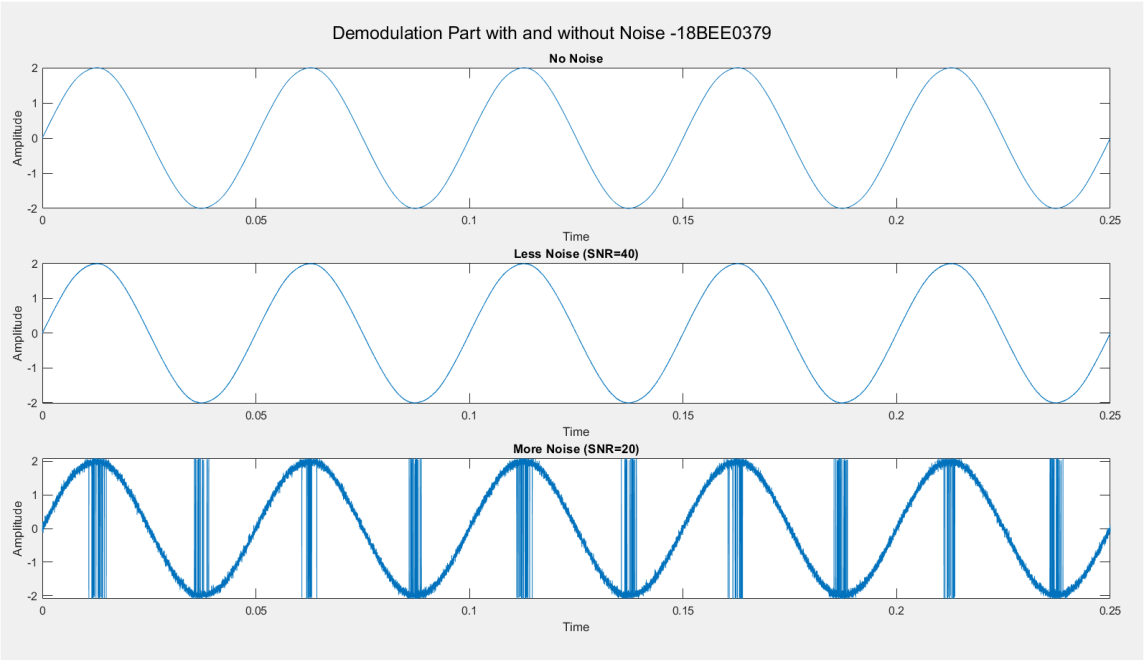
```
v_no = vinpm;
v_no_d = pmdemod(vinpm,fc,fs,pd);

% Less Noise
SNR = 40;
v_less = awgn(vinpm,SNR);
v_less_d = pmdemod(v_less,fc,fs,pd);

%More Noise
SNR = 20;
v_more = awgn(vinpm,SNR);
v_more_d = pmdemod(v_more,fc,fs,pd);

%Modulation Part
figure(3);
subplot(3,1,1); plot(t,v_no);
xlabel("Time"); ylabel("Amplitude"); title('No Noise');
subplot(3,1,2); plot(t,v_less);
xlabel("Time"); ylabel("Amplitude"); title('Less Noise (SNR=40)');
subplot(3,1,3); plot(t,v_more);
xlabel("Time"); ylabel("Amplitude"); title('More Noise (SNR=20)');
sgtitle("Modulation Part with and without Noise");

%Demodulation Part
figure(4);
subplot(3,1,1); plot(t,v_no_d);
xlabel("Time"); ylabel("Amplitude"); title('No Noise');
subplot(3,1,2); plot(t,v_less_d);
xlabel("Time"); ylabel("Amplitude"); title('Less Noise (SNR=40)');
subplot(3,1,3); plot(t,v_more_d);
xlabel("Time"); ylabel("Amplitude"); title('More Noise (SNR=20)');
sgtitle("Demodulation Part with and without Noise");
```

OUTPUT:




Phase Modulation and Demodulation
Phase Modulated Output using Inbuilt Function -18BEE0379
Phase Modulated Output using Mathematical Expression -18BEE0379
Phase Demodulated Output for Inbuilt Function (pmmod) -18BEE0379
Phase Modulated Output using Mathematical Expression -18BEE0379
Amplitude
Time


Modulation Part with and without Noise -18BEE0379
No Noise
Less Noise (SNR=40)
More Noise (SNR=20)
Amplitude
Time


Demodulation Part with and without Noise -18BEE0379
No Noise
Less Noise (SNR=40)
More Noise (SNR=20)
Amplitude
Time

3. Generate FM modulation using pspice and calculate the modulation index.

AIM:

To design and setup an Frequency modulator circuit using 555 IC and measure its modulation index.

- **Note down the properties of message, Carrier and modulated signals.**
- **Calculate the peak frequency deviation and modulation Index.**
- **Draw the graph for message, Carrier and modulated signals.**
- **Upload the images of message, Carrier and modulated Signals.**

THEORY:

- The standard design equation for an astable multivibrator using 555 IC is defined by the equation is

$$T=1.38RC$$

OR

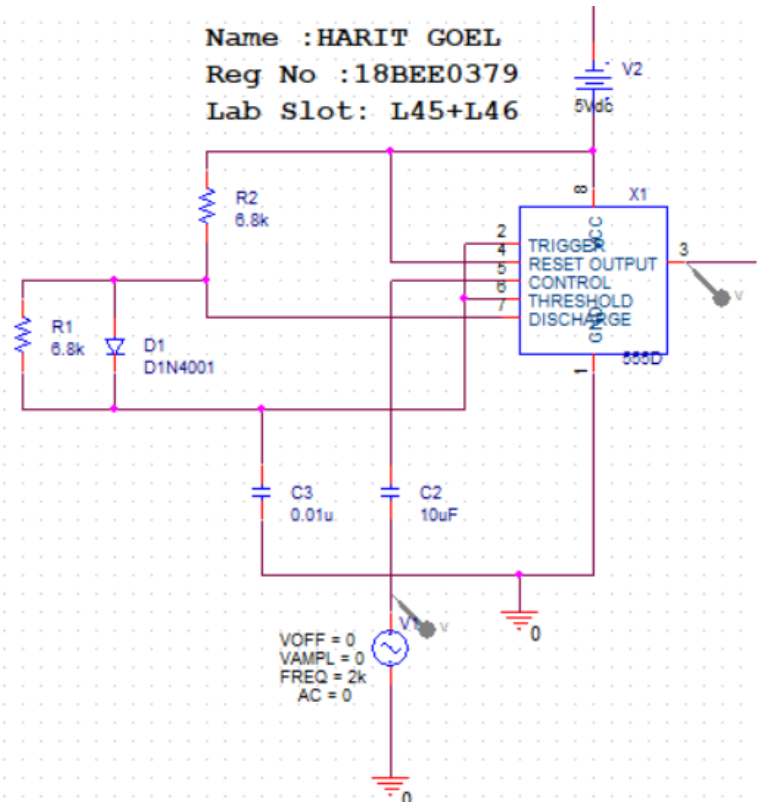
frequency of oscillation is $f_o=0.72/RC$

OR

$f_o = 1/(1.38RC)$, where R = R1 = R2 and C = C1

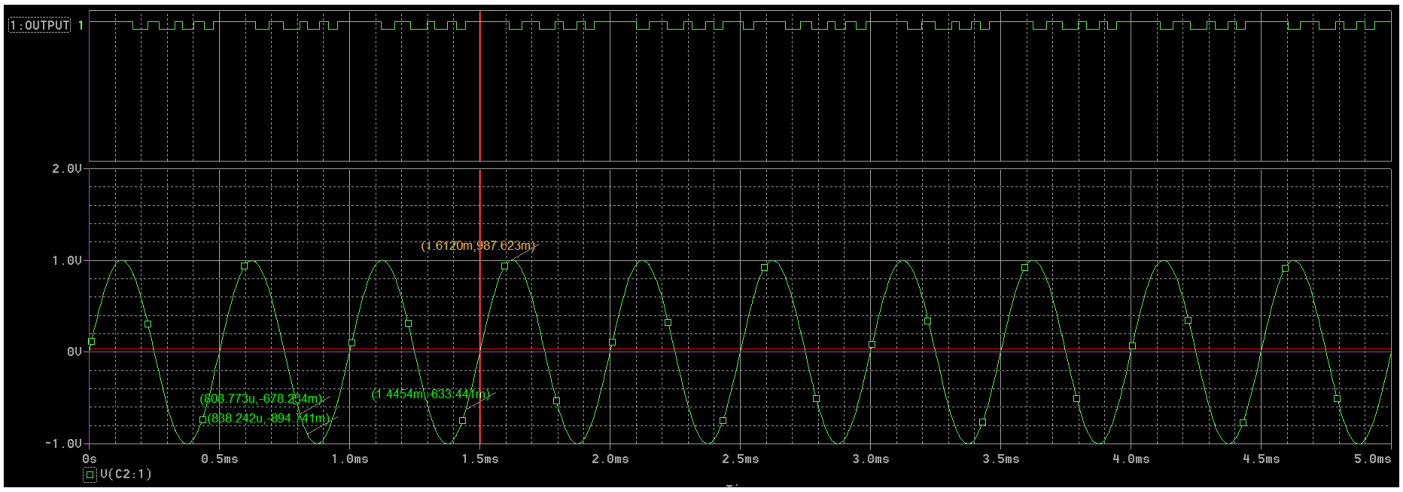
- This frequency of oscillation remain constant as long as the pin-5 is supplied with a constant voltage.
- If the voltage at the pin -5 is the varying, the frequency of oscillation of the astable multivibrator aslo changes along with it.
- Thus astable multivibrator using 555 IC can be used as a carrier pulse generator.
- The frequency of the carrier can be varied by feeding the pin-5 with message signal.

PSPICE CIRCUIT:

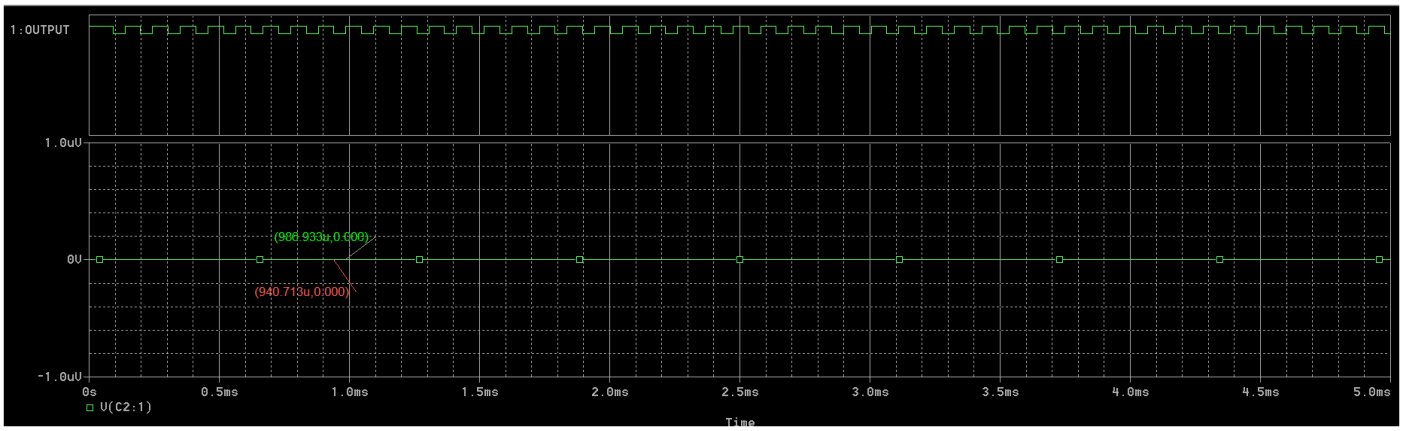


SIMULATION OUTPUT:

(a)With 1V amplitude sinusoidal message signal (to calculate $\delta f = (fmax - fmin)$)



(b)With 0V amplitude i.e., NO message signal (to calculate frequency of message).



CALCULATION:

Modulation Index in FM = (frequency deviation / frequency of the message)

We have –

frequency of message = (986.933u - 940.713u) =46.22*10^{-6}
frequency deviation →
fmin=(838.242u -808.773u)= 29.469*10^{-6}
fmax=(1.612m-1.4454m)=0.1666*10^{-3} = 166.6*10^{-6}
δf = (166.6-29.469)*2*1e-6 = 2*137.131*1e-6
So **Modulation Index (m)** = (2*137.131)/29.469 = 5.933 ~=6 ;

RESULTS: We have successfully completed the objective and verified the results accordingly with graphs and calculations accordingly